1. Introduction

1.1 Overview

This 2002 periodic PM_{10} emissions inventory was developed to meet requirements set forth in Title I of the Clean Air Act Amendments of 1990 (CAAA). The CAAA require development of a baseline emission inventory and periodic revisions for areas that fail to meet the National Ambient Air Quality Standards (NAAQS). A portion of Maricopa County is classified as serious nonattainment for PM_{10}.

PM_{10} is defined as particulate matter less than ten micrometers in diameter. This inventory includes primary emissions of PM_{10} and $PM_{2.5}$ as well as three particulate matter precursors: nitrogen oxides (NO_x), sulfur dioxides (SO_x) and ammonia (NH_3). The inventory provides emission estimates from point, area, nonroad mobile, onroad mobile, and biogenic sources. Note that totals shown in tables may not equal the sum of individual values due to independent rounding.

1.2 Agencies responsible for the emissions inventory

Maricopa County Environmental Services Department (MCESD) has primary responsibility for preparing and submitting the 2002 Periodic PM_{10} Emissions Inventory for Maricopa County. Point, area, and nonroad mobile source emission estimates for aircraft and locomotives were prepared by MCESD. The remaining nonroad mobile emission estimates were developed by ENVIRON International Corporation (Environ *et al.*, 2003), with additional work conducted by MCESD to develop estimates for the nonattainment area and a typical day. The Maricopa Association of Governments (MAG) prepared the onroad mobile and biogenic emissions estimates. Table 1.2–1 lists those responsible for inventory preparation and quality assurance/ quality control activities, which are described in the respective chapters.

Table 1.2–1. Chapter authors and QA/QC contacts.

Chapter	Author(s)	QA/QC contact persons
Point Sources	Bob Downing MCESD (602) 506-6790	Matt Poppen, Eric Raisanen and Dena Konopka MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Area Sources	Matt Poppen, Eric Raisanen and Dena Konopka MCESD (602) 506-6790	Bob Downing MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Nonroad Mobile Sources	Matt Poppen and Eric Raisanen MCESD (602) 506-6790	Bob Downing and Dena Konopka MCESD (602) 506-6790 Ruey-in Chiou and Scott DiBiase MAG (602) 254-6300
Onroad Mobile Sources	Roger Roy MAG (602) 254-6300	Ruey-in Chiou MAG (602) 254-6300 Bob Downing and Dena Konopka MCESD (602) 506-6790
Biogenic Sources	Steve Ochs MAG (602) 254-6300	Ruey-in Chiou MAG (602) 254-6300 Bob Downing and Dena Konopka MCESD (602) 506-6790

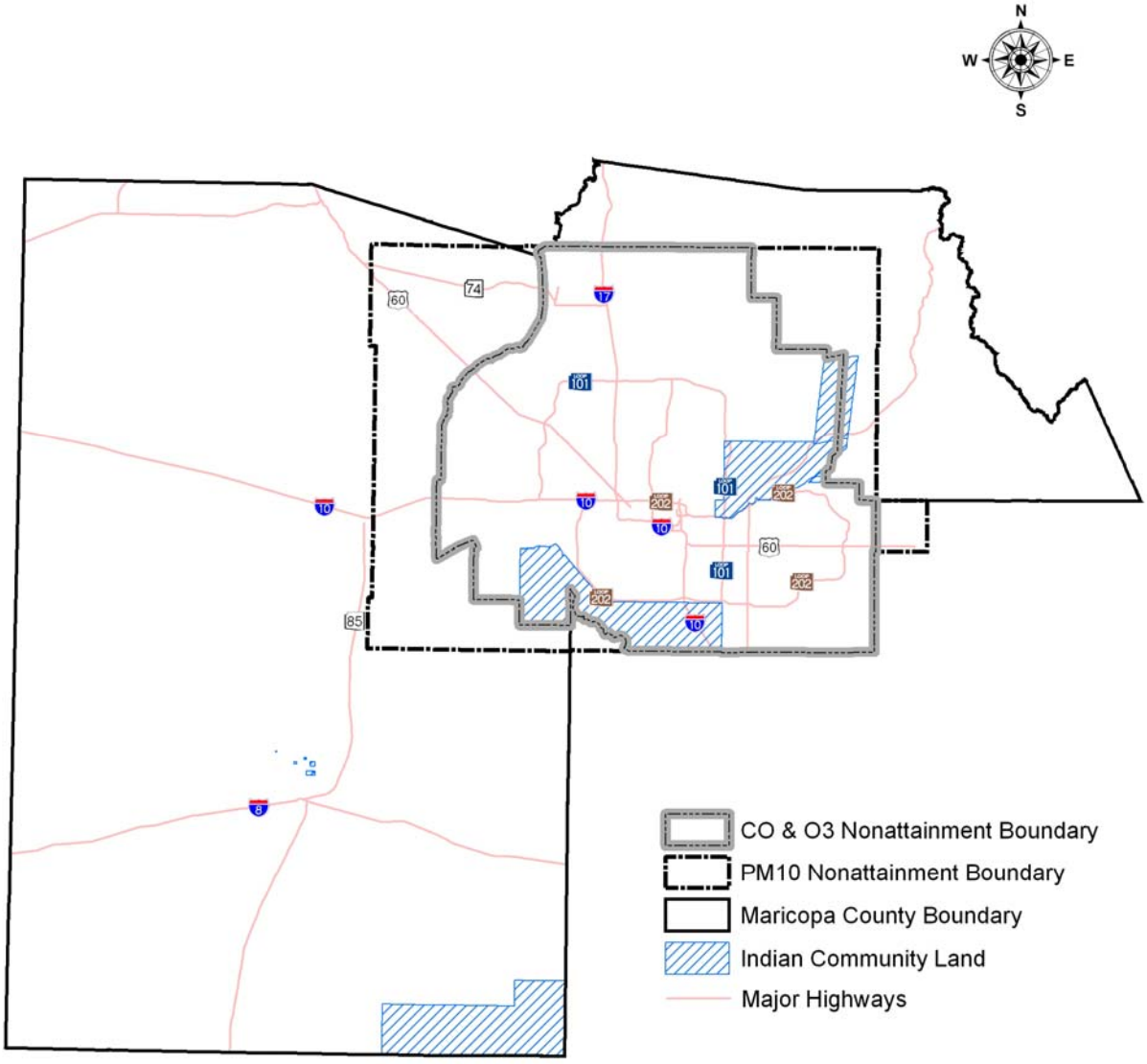
1.3 Temporal scope

Annual and typical daily emissions were estimated for the year 2002, for Maricopa County and the Maricopa County PM_{10} nonattainment area (NAA).

1.4 Geographic scope

This inventory includes emission estimates for Maricopa County and for the Maricopa County PM_{10} nonattainment area. Maricopa County encompasses approximately 9,223 square miles of land area, while the Maricopa County PM_{10} nonattainment area is approximately 2,880 square miles or approximately 31 percent of the Maricopa County land area. A map of Maricopa County and the PM_{10} nonattainment area is provided in Figure 1.4–1.

Figure 1.4–1. Map of Maricopa County and the CO, ozone, and PM_{10} nonattainment areas.



1.5 Overview of local demographic and land-use data

Many of the emissions estimates generated in this report were calculated using demographic and land-use data provided by the Maricopa Association of Governments (MAG). These data were used to apportion and/or scale Maricopa County emissions estimates to the nonattainment area and vice versa. (For example, county-level emissions from residential natural gas usage in Maricopa County was apportioned to the nonattainment area using the ratio of occupied households in each area). Detailed explanations of how emission estimates were apportioned or scaled are presented in each of the following chapters, along with the data sources used.

1.5.1 Demographic profile

The demographic data provided by MAG included population, housing and employment data for calendar year 2002, for Maricopa County and the nonattainment area. Table 1.5–1 provides an overview of the demographic data used in this report.

Table 1.5–1. Demographic profile of Maricopa County and the PM_{10} nonattainment area.

Demographic variable	Maricopa County	Within PM_{10} NAA	Percent within PM_{10} NAA
Total resident population	3,296,250	3,267,804	99.14%
Total non-resident population	253,443	251,484	99.23%
Total population:	**3,549,693**	**3,519,288**	**99.14%**
Occupied resident housing units	1,215,173	1,205,176	99.18%
Total non-resident households	146,664	145,541	99.23%
Total occupied households:	**1,361,837**	**1,350,717**	**99.18%**
Retail employment	438,674	434,263	98.99%
Office employment	392,383	391,819	99.86%
Industrial employment	383,938	379,757	98.91%
Public employment	221,676	214,954	96.97%
Other employment	232,614	230,547	99.11%
Total employment:	**1,669,285**	**1,651,340**	**98.92%**

1.5.2 Land-use data

The most recent land-use data available from MAG was for the year 2000. The 2000 land-use data was assumed to be representative of 2002. Table 1.5–2 presents a summary of the land-use categories and acreage used to develop emission estimates for this inventory. Note that the land-use data used to model emissions from biogenic sources is different from the land-use data discussed here. See Chapter 6 for a discussion of the biogenic land-use data.

Table 1.5–2. Land-use categories used to apportion emissions.

Description	Acreage in Maricopa County	Acreage within PM_{10} NAA	Percent within PM_{10} NAA
Active open space (e.g., parks)	127,792	121,231	94.87%
Passive open space (e.g., mountain preserves)	2,057,048	175,487	8.53%
General open space (not elsewhere classified)	849	849	100.00%
Golf courses	22,922	22,844	99.66%
Water	110,940	53,565	48.28%
Agriculture	415,473	222,124	53.46%
Vacant (e.g., developable land)	2,653,351	749,516	28.25%

1.6 Emissions overview by source category

1.6.1 Point sources

The point source category includes those stationary sources that emit a significant amount of pollution into the air such as power plants, industrial processes and large manufacturing facilities. As Maricopa County has an established annual reporting program for sources with air quality permits, the thresholds for defining a point source are lower than the minimums required by the US EPA. For the purposes of this inventory, a point source is a stationary operation within Maricopa County or within 25 miles of the PM_{10} nonattainment area, which in 2002 emitted:

- 25 English (short) tons or more of carbon monoxide (CO); or
- 10 tons or more of volatile organic compounds (VOC), oxides of nitrogen (NO_x), or sulfur oxides (SO_x); or
- 5 tons or more of particulate matter less than 10 microns (PM_{10}) or ammonia compounds (NH_x).

Tables 1.6–1 and 1.6–2 summarize annual and typical daily emissions from point sources in Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for all point sources is contained in Chapter 2.

Table 1.6–1. Summary of annual and typical daily emissions from point sources in Maricopa County.

	Annual (tons/yr)					Typical day (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Electricity generation	243.38	243.38	2,783.19	23.97	93.78	1,351.5	1,351.5	15,336.5	133.0	515.7
Comm./Inst. fuel combustion	4.88	4.72	103.90	3.38	0.23	34.9	33.4	769.9	24.6	1.3
Industrial fuel combustion	77.57	55.58	481.08	84.59	6.13	487.0	355.6	3,260.1	571.5	49.8
Food/agriculture	60.89	7.16				353.6	42.4			
Industrial processes	696.92	257.81	60.74	59.05	17.22	4,328.5	1,613.2	342.0	371.2	159.2
Manufacturing processes	157.06	124.15	65.13	18.24	5.74	1,154.7	915.4	466.1	139.7	34.5
Waste disposal	42.51	39.51	27.51	29.88		233.7	217.2	155.5	164.3	
All point sources:	**1,283.19**	**732.31**	**3,521.55**	**219.10**	**123.10**	**7,943.9**	**4,528.7**	**20,330.2**	**1,404.3**	**760.5**

Table 1.6–2. Summary of annual and typical daily emissions from point sources in the PM_{10} NAA.

	Annual (tons/yr)					Typical day (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Electricity generation	120.24	120.24	2,560.30	11.94	44.42	660.7	660.7	14,067.6	65.6	244.1
Comm./Inst. fuel combustion	4.88	4.72	103.90	3.38	0.23	34.9	33.4	769.9	24.6	1.3
Industrial fuel combustion	75.57	53.78	416.42	83.31	6.13	474.8	344.6	2,887.6	563.3	49.8
Food/agriculture	28.00	3.60				154.7	20.3			
Industrial processes	611.48	194.21	60.74	59.05	6.35	3,811.2	1,233.5	342.0	371.2	34.9
Manufacturing processes	154.48	121.57	52.24	17.05	5.74	1,134.9	895.5	366.9	130.6	34.5
Waste disposal	41.96	39.14	26.24	29.38		230.7	215.2	148.5	161.6	
All point sources:	**1,036.60**	**537.26**	**3,219.83**	**204.10**	**62.86**	**6,501.8**	**3,403.2**	**18,582.5**	**1,316.9**	**364.5**

1.6.2 Area sources

Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively they can release significant amounts of a pollutant. Stationary sources with annual emissions lower than the point source thresholds described in Section 1.6.1 were included in the area source inventory. Examples of area source categories include residential wood burning, commercial cooking, waste incineration and wildfires.

Tables 1.6–3 and 1.6–4 summarize annual and season-day emissions of the chief area source categories, for Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for each area source category is contained in Chapter 3.

Table 1.6–3. Summary of annual and typical daily emissions from area sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel combustion	743.52	712.72	4,560.90	238.60	13.65	6,749.6	6,409.2	28,675.4	1,550.0	87.5
Industrial processes	19,974.43	4,683.60	589.86	157.46	1,672.79	152,018.5	34,546.4	5,318.0	1,265.4	10,722.2
Waste treatmt/disposal	111.58	109.76	67.36	2.67	1,230.86	938.8	927.5	519.3	15.4	6,744.4
Misc. area sources	28,855.85	6,365.39	95.36	18.22	6,476.27	334,886.8	177,457.1	36,603.3	9,971.5	43,028.9
All area sources:	**49,685.38**	**11,871.47**	**5,313.47**	**416.94**	**9,393.56**	**494,593.6**	**219,340.2**	**71,116.0**	**12,802.3**	**60,582.9**

Table 1.6–4. Summary of annual and typical daily emissions from area sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel combustion	736.81	706.26	4,513.93	236.06	13.50	6,690.3	6,352.7	28,379.0	1,533.5	86.5
Industrial processes	19,149.15	4,511.99	589.67	157.45	1,654.64	145,691.2	33,240.8	5,316.9	1,265.4	10,605.8
Waste treatmt/disposal	43.56	41.74	49.13	2.67	1,220.31	373.5	362.2	367.9	15.4	6,686.6
Misc. area sources	13,661.81	2,958.31	32.22	3.30	3,902.06	81,136.1	17,469.6	285.4	26.5	21,381.1
All area sources:	**33,591.32**	**8,218.30**	**5,184.95**	**399.48**	**6,790.51**	**233,890.9**	**57,425.4**	**34,349.2**	**2,840.8**	**38,760.2**

1.6.3 Nonroad mobile sources

Nonroad mobile sources include off-highway vehicles and engines that move or are moved within a 12-month period. Tables 1.6–5 and 1.6–6 summarize annual and season-day emissions from nonroad mobile sources, for Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for each source category is contained in Chapter 4.

Table 1.6–5. Annual and typical daily emissions from nonroad mobile sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	56.90	52.35	477.46	6.59	0.96	364.8	335.7	3,060.7	42.3	6.1
Airport ground support	4.67	4.31	147.09	1.67	3.41	25.7	23.7	808.1	9.2	18.7
Commercial	120.50	110.95	1,319.44	19.28	21.68	772.4	711.1	8,457.9	123.5	139.0
Construction & mining	859.34	790.60	9,834.69	154.05	19.47	5,508.6	5,067.9	63,042.9	987.6	124.9
Industrial	107.22	99.38	3,174.80	22.45	77.69	687.6	637.1	20,351.3	143.9	498.0
Lawn & garden	141.59	130.27	695.48	15.20	17.54	974.6	896.7	4,286.3	108.4	128.8
Logging	3.25	2.99	38.74	0.71	0.09	20.8	19.1	248.3	4.6	0.6
Pleasure craft	27.23	25.06	43.01	0.88	1.02	366.5	337.2	579.1	11.7	13.7
Railway maintenance	3.05	2.81	20.35	0.27	0.05	21.1	19.5	140.9	1.9	0.3
Recreational	4.53	4.17	63.35	2.29	1.92	38.8	35.7	541.4	19.6	16.5
Aircraft	15,987.67	11,030.94	4,187.66	295.81	0.00	87,603.7	60,443.5	22,946.1	1,620.9	0.0
Locomotives	86.76	76.16	3,444.32	201.30	5.31	475.4	417.3	18,873.0	1,103.0	29.1
All nonroad mobile sources:	**17,402.71**	**12,329.99**	**23,446.39**	**720.50**	**149.14**	**96,860.0**	**68,944.5**	**143,336.0**	**4,176.6**	**975.7**

Table 1.6–6. Annual and typical daily emissions from all nonroad mobile sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	30.42	27.99	255.25	3.52	0.51	195.0	179.4	1,636.2	22.6	3.2
Airport ground support	4.55	4.20	143.42	1.63	3.33	25.1	23.1	787.9	9.0	18.2
Commercial	119.17	109.74	1,305.06	19.07	21.46	763.9	703.4	8,365.7	122.2	267.6
Construction & mining	851.95	783.80	9,750.12	152.73	19.31	5,461.2	5,024.4	62,500.8	979.1	123.9
Industrial	106.05	98.30	3,140.20	22.19	76.84	680.1	630.1	20,129.5	142.4	492.6
Lawn & garden	140.43	129.20	689.78	15.07	17.40	966.7	889.3	4,251.2	107.5	127.8
Logging	3.22	2.96	38.40	0.70	0.09	20.7	19.0	246.2	4.6	0.6
Pleasure craft	13.15	12.10	20.77	0.42	0.49	177.0	162.8	279.6	5.7	6.6
Railway maintenance	3.02	2.79	20.18	0.27	0.05	20.9	19.3	139.7	1.9	0.3
Recreational	0.91	0.83	12.68	0.46	0.39	7.8	7.2	108.4	3.9	3.3
Aircraft	15,985.12	11,029.19	4,186.89	295.66	0.00	87,589.7	60,433.9	22,941.9	1,620.1	0.0
Locomotives	44.85	39.83	1,781.60	100.70	2.66	245.7	218.2	9,762.2	551.8	14.6
All nonroad mobile sources:	**17,302.84**	**12,240.93**	**21,344.35**	**612.42**	**142.53**	**96,153.8**	**68,310.1**	**131,149.3**	**3,570.8**	**1,058.7**

1.6.4 Onroad mobile sources

Emission from onroad mobile sources were calculated for the PM_{10} nonattainment area located primarily within Maricopa County, as well as for Maricopa County as a whole. A detailed breakdown of emissions calculations for each area source category is contained in Chapter 5.

Tables 1.6–7 and 1.6–8 summarize annual and typical daily emissions from onroad mobile sources in Maricopa County and the PM_{10} nonattainment area, respectively.

Table 1.6–7. Annual and typical daily emissions from all onroad mobile sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Exhaust	1,285	1,176	79,572	1,183	2,544	7,039	6,446	436,006	6,479	13,937
Paved road fugitive dust	20,046	2,374				109,838	13,007			
Unpaved road fugitive dust	9,562	1,432				52,392	7,846			
Tire wear	287	71				1,574	390			
Brake wear	370	157				2,028	860			
All onroad mobile sources:	**31,550**	**5,210**	**79,572**	**1,183**	**2,544**	**172,872**	**28,550**	**436,006**	**6,479**	**13,937**

Table 1.6–8. Annual and typical daily emissions from all onroad mobile sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Exhaust	1,223	1,120	75,307	1,125	2,418	6,700	6,135	412,639	6,166	13,250
Paved road fugitive dust	19,241	2,276				105,431	12,474			
Unpaved road fugitive dust	9,142	1,369				50,093	7,502			
Tire wear	273	68				1,497	370			
Brake wear	352	149				1,929	818			
All onroad mobile sources:	**30,231**	**4,982**	**75,307**	**1,125**	**2,418**	**165,649**	**27,300**	**412,639**	**6,166**	**13,250**

1.6.5 Biogenic sources

The biogenic source category includes emissions from all vegetation (e.g., crops, indigenous vegetation, landscaping, etc.) in Maricopa County and the PM_{10} nonattainment area. Emissions were estimated through MAG-BEIS2, a local computer model developed by the Maricopa Association of Governments (MAG) that is based on the US EPA model UAM-BEIS2, but which uses county-specific land-use and temperature data. Annual and daily NO_x emissions from biogenic sources are shown in Table 1.6–9 for Maricopa County and the PM_{10} nonattainment area.

Table 1.6–9. Annual and season-day NO_x emissions from biogenic sources.

Geographic area	**Annual emissions (tons/yr)**	**Typical daily emissions (lbs/day)**
Maricopa County	8,327	45,626
PM_{10} NAA	2,447	13,408

1.6.6 Summary of emissions by source category

Figures 1.6–1 through 1.6–10 provide a graphical overview of the relative contributions of the major source categories (point, area, nonroad, onroad and biogenic) to emissions in the PM_{10} nonattainment area, on an annual and season-day basis, respectively.

Figure 1.6–1. Annual PM_{10} emissions in the PM_{10} nonattainment area, by source category (tons/yr).

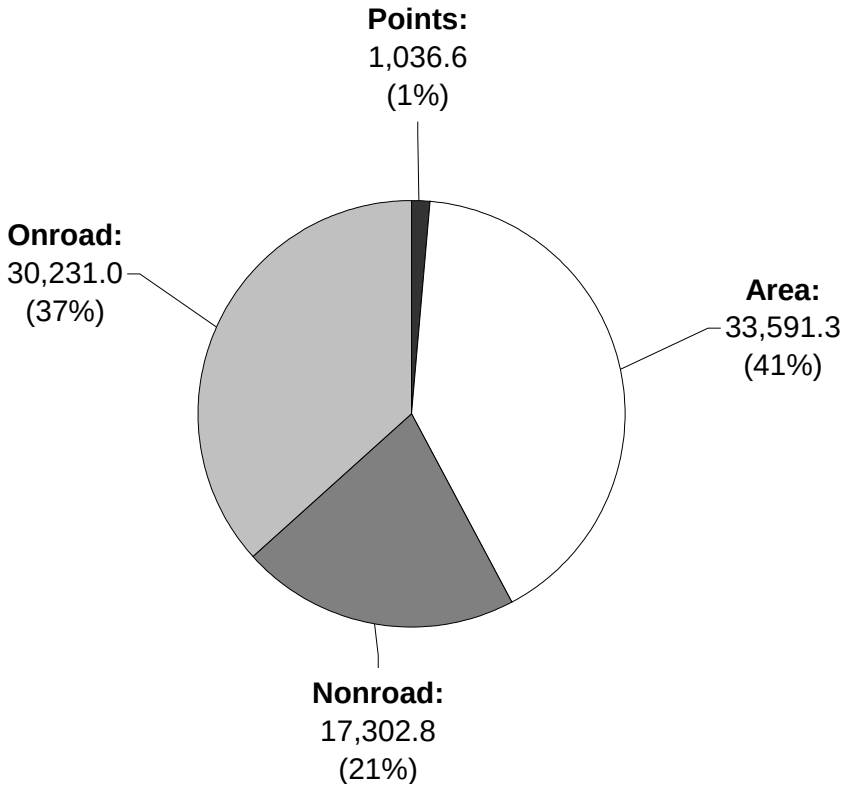


Figure 1.6–2. Annual $PM_{2.5}$ emissions in the PM_{10} nonattainment area, by source category (tons/yr).

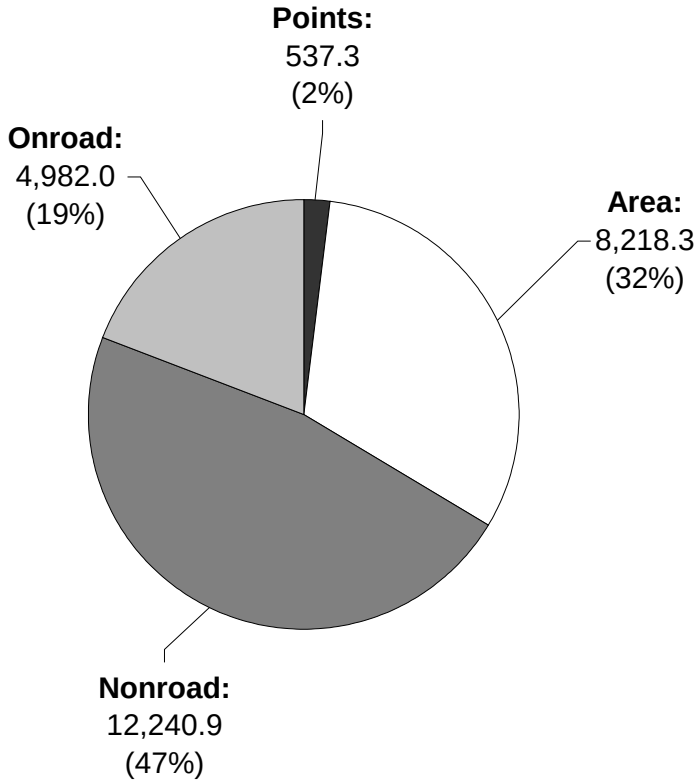


Figure 1.6–3. Annual NO_x emissions in the PM_{10} nonattainment area, by source category (tons/yr).

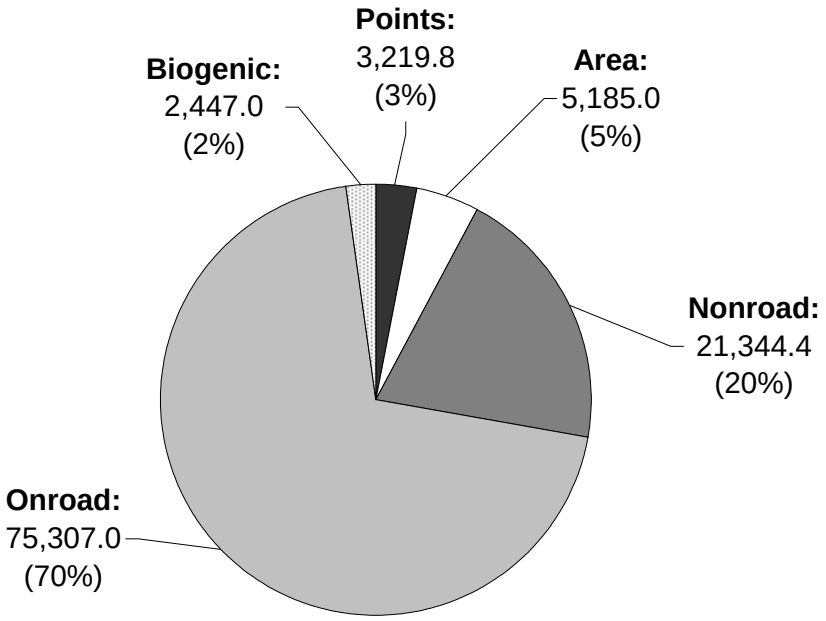


Figure 1.6–4. Annual SO_x emissions in the PM_{10} nonattainment area, by source category (tons/yr).

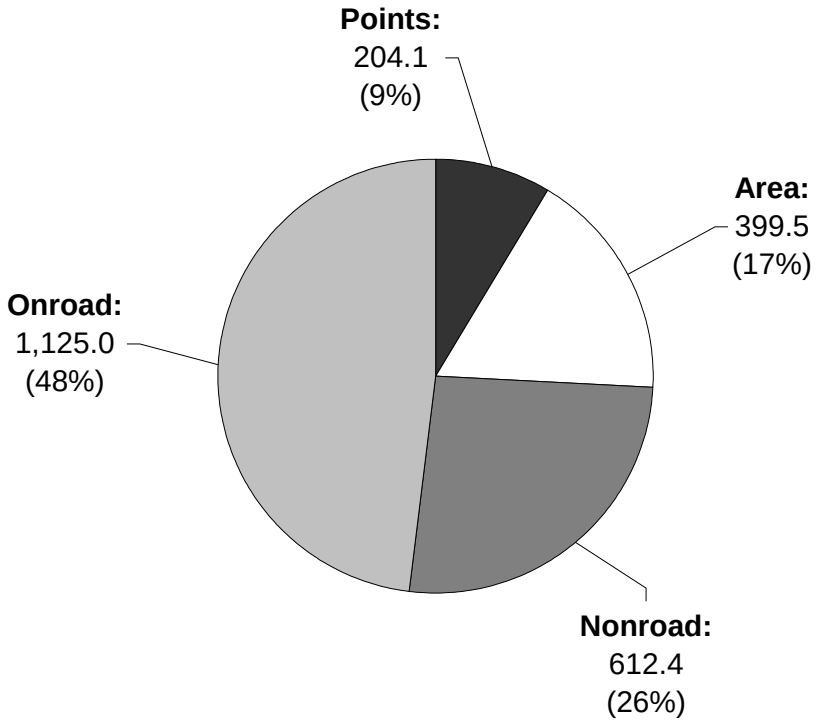


Figure 1.6–5. Annual NH_3 emissions in the PM_{10} nonattainment area, by source category (tons/yr).

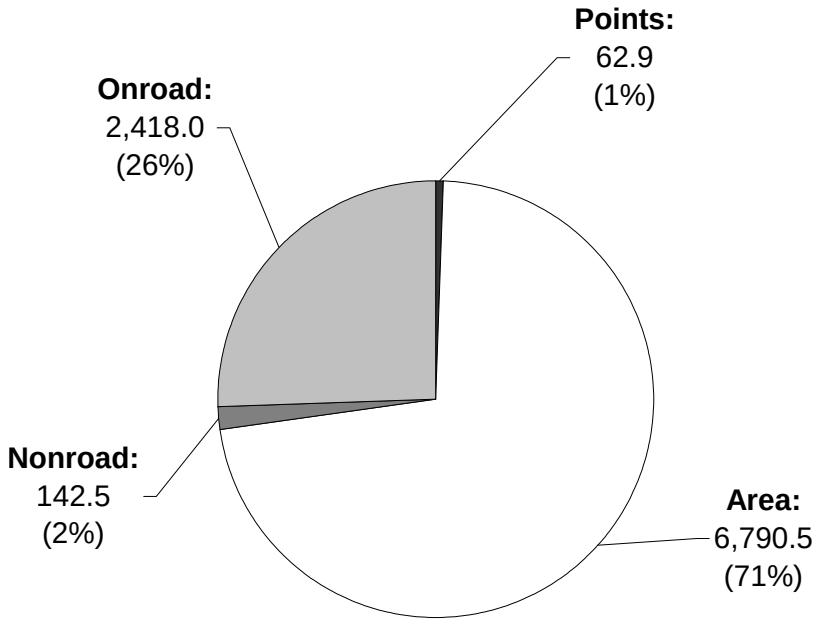


Figure 1.6–6. Typical daily PM_{10} emissions in the PM_{10} nonattainment area, by source category (lbs/day).

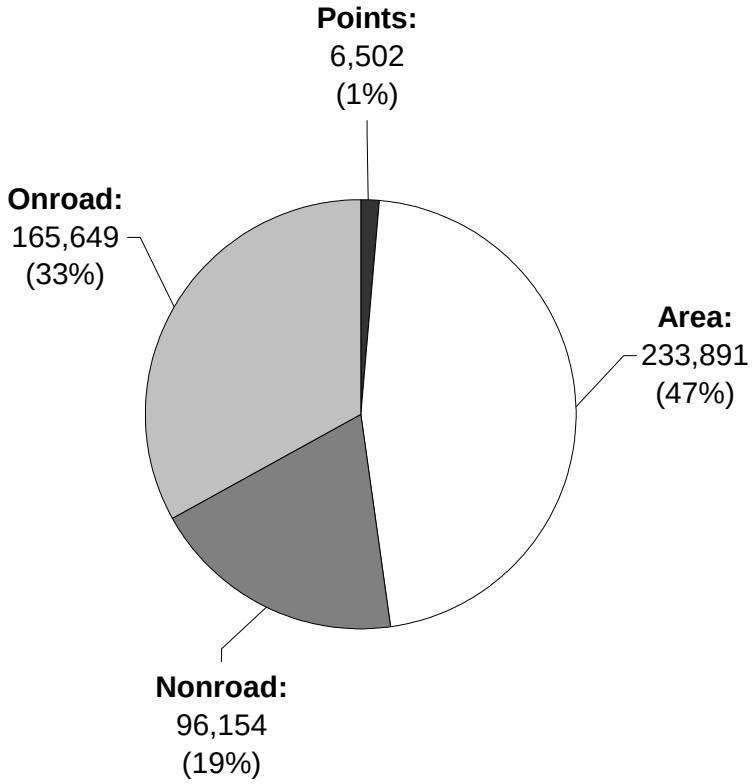


Figure 1.6–7. Typical daily $PM_{2.5}$ emissions in the PM_{10} nonattainment area, by source category (lbs/day).

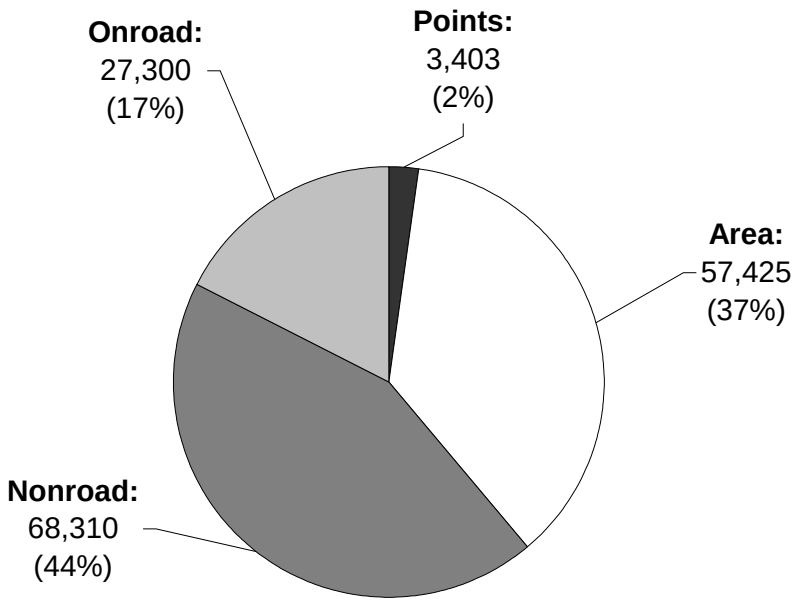


Figure 1.6–8. Typical daily NO_x emissions in the PM_{10} nonattainment area, by source category (lbs/day).

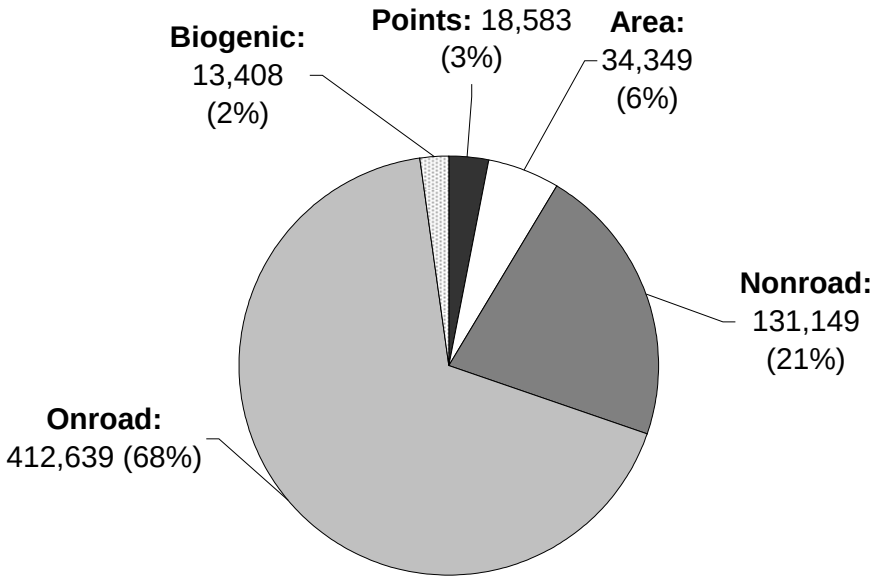


Figure 1.6–9. Typical daily SO_x emissions in the PM_{10} nonattainment area, by source category (lbs/day).

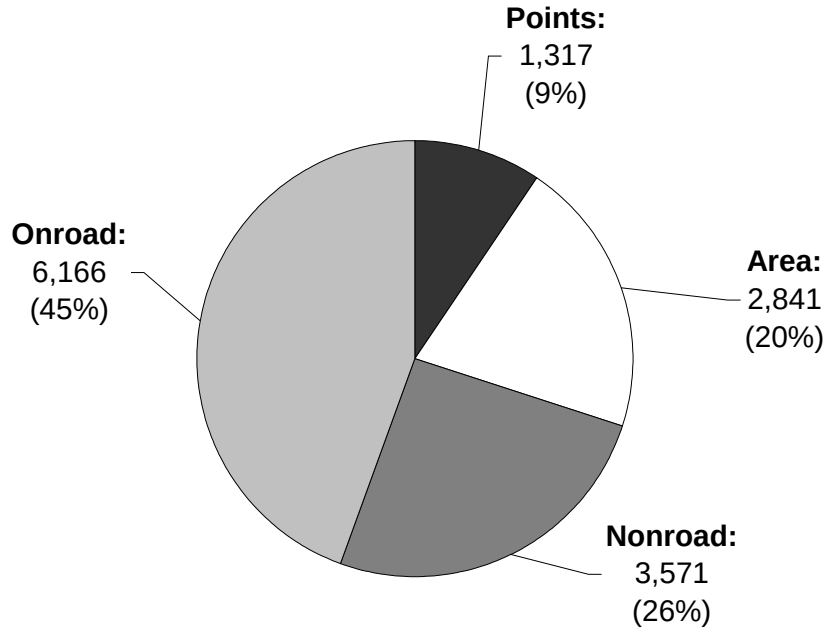
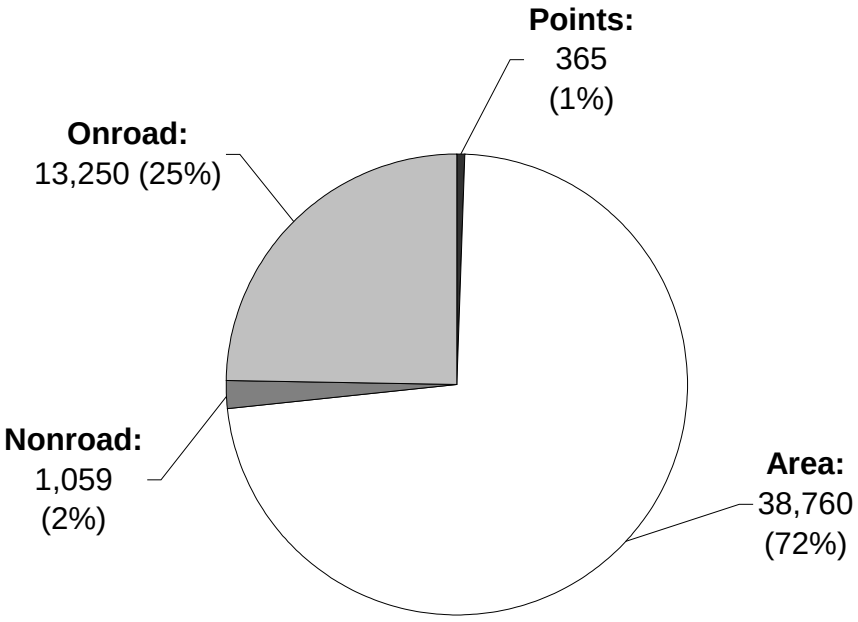


Figure 1.6–10. Typical daily NH_3 emissions in the PM_{10} nonattainment area, by source category (lbs/day).



Figures 1.6–11 and 1.6–12 show the relative contributions of each source category for each pollutant on an annual and season-day basis, respectively.

Figure 1.6–11. Annual emissions in the PM_{10} nonattainment area, by source category (TPY).

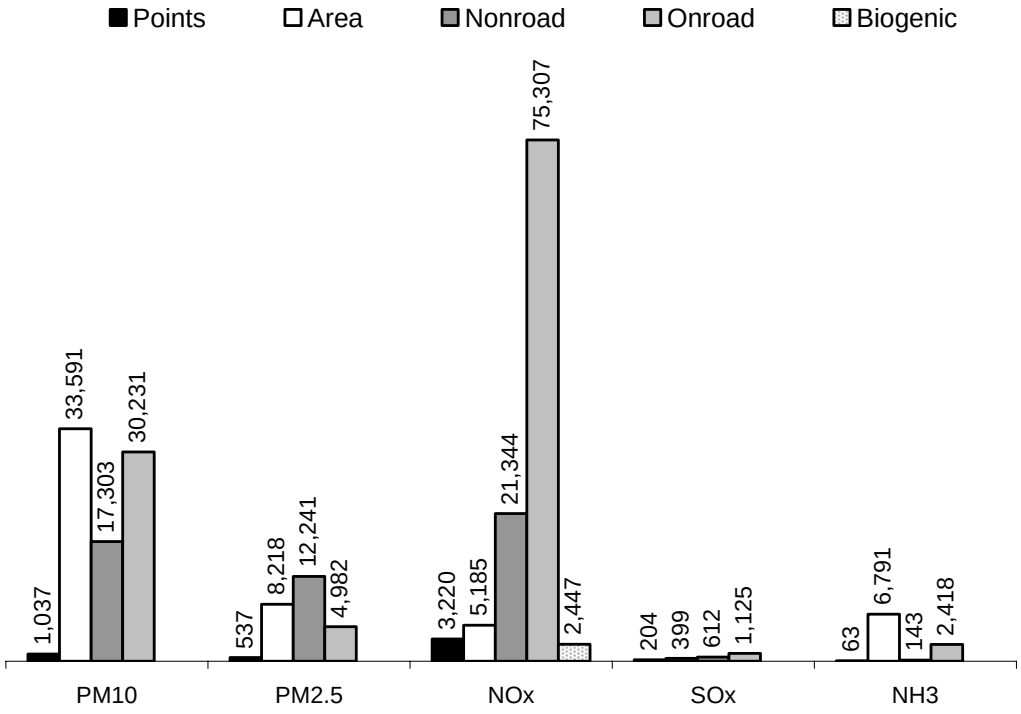


Figure 1.6–12. Typical daily emissions in the PM_{10} nonattainment area, by source category (lb/day).

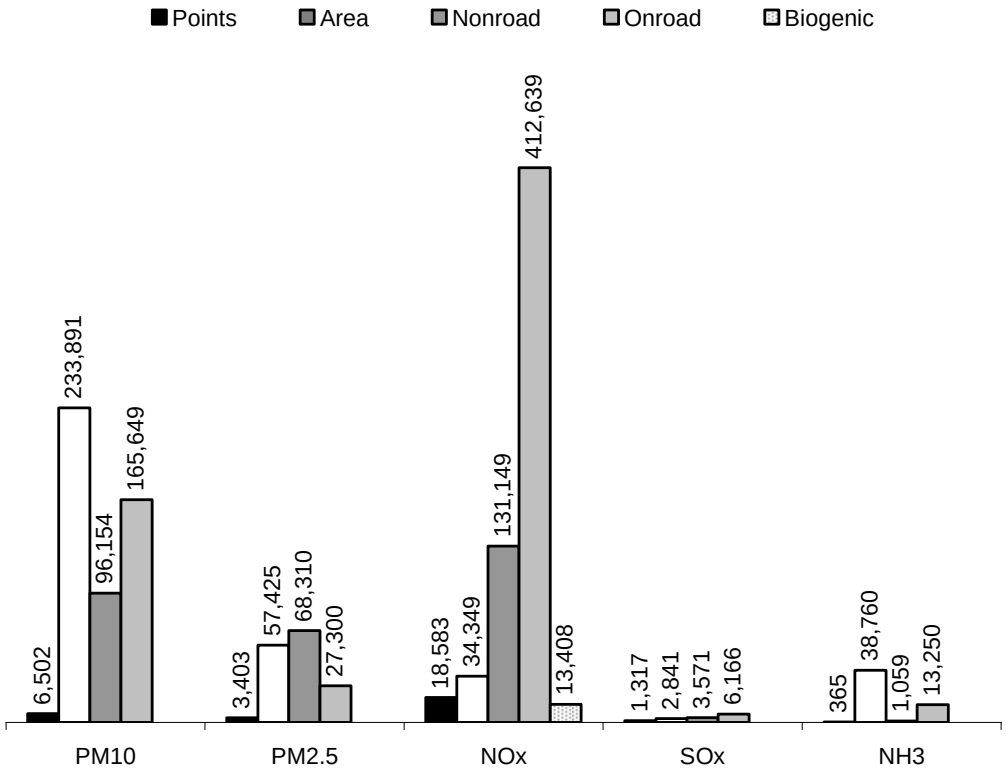


Table 1.6–10 provides a comparison between this inventory and earlier periodic PM emissions inventories for the PM_{10} nonattainment area. Note that figures may not be directly comparable as calculation methods, emission factors, and source category definitions (e.g., point vs. area sources) may have changed over time. Prior-year inventories that did not include annual totals for a specific source category are denoted by "n/c", for not calculated.

Table 1.6–10. Summary of annual emissions by source category, 1994–2002 (tons/yr).

	Inventory year 1994					Inventory year 2002				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Points	1,238	683	5,540	610	7	1,037	537	3,220	204	63
Area	10,460	6,257	4,100	535	5,687	33,591	8,218	5,185	399	6,791
Nonroad	13,851	7,335	42,689	2,579	n/c	17,303	12,241	21,344	612	143
Onroad	37,015	13,049	63,372	217	n/c	30,231	4,982	75,307	1,125	2,418
Biogenic	n/c	n/c	1,782	n/c	n/c	n/c	n/c	2,447	n/c	n/c
Totals:	**62,564**	**27,324**	**117,483**	**3,941**	**5,694**	**82,161**	**25,978**	**107,503**	**2,341**	**9,415**

1.7 References

ENVIRON *et al.*, 2003. Maricopa County 2002 Comprehensive Emission Inventory for the Cap and Trade Oversight Committee, Final Rep. prepared for Arizona Dept. of Environmental Quality, October 9, 2003.